VIII: Impact of Superpave on HMA Construction

To meet the Superpave mix design requirements, personnel in the asphalt industry may begin working with materials that are slightly or even drastically different than those they have encountered previously. Although many current sources of materials can be used in Superpave, some may not be acceptable for every design situation and new sources of materials may be required. Binders with different handling characteristics may be specified. Different sizes and size distributions of aggregates from local sources may be required to create appropriate gradations for Superpave mixtures.

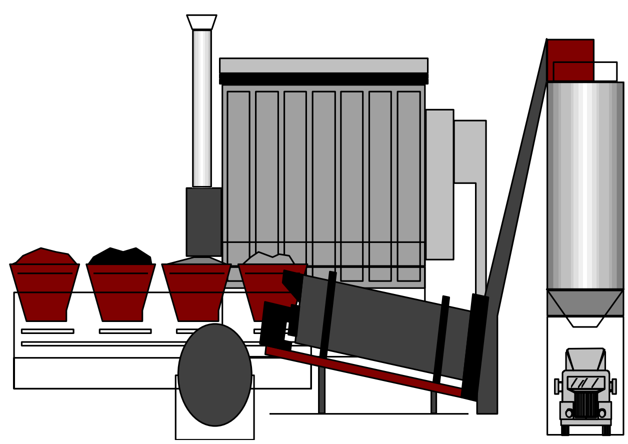
Using these new materials has the potential to affect the production and construction characteristics of the resulting mixture. Experience, to date, with Superpave mixes has generally been good, but there have been a few problems. These problems have been very similar to those experienced with conventional HMA when new practices are introduced. The degree of difference encountered with Superpave will depend on prior practice. If the commonly used mixes are fine-graded and contain appreciable quantities of rounded sands, more fines, and/or relatively high asphalt contents (which make paving "easy"), significant differences in the overall construction process will be noted. However, if the producer is already familiar with mixes having a high degree of stone-to-stone contact (such as SMA), the differences will not be as pronounced. Depending on climate and traffic, a modified asphalt binder may be selected for the project mixture. If the producer has no experience with modified asphalt binders, adjustments to the construction process may be required. It is important that past experience with similar materials not be ignored. The same, proper handling and construction practices used to build HMA pavements that met performance expectations generally are needed with Superpave projects.

To foster a complete understanding of what is involved with Superpave mixes, it is strongly recommended that a prepaving conference be held with all involved parties. If expected differences in materials characteristics are identified and anticipated in the design process, as well as recognized and communicated in the construction phase, the impact need not be significant.

This section is intended to describe how Superpave mixtures *could* behave differently during some of the phases of construction as well as offer suggestions for modifying current handling operations.

MATERIALS HANDLING AND PLANT OPERATIONS

Superpave mixes may or may not contain components that are different from previous experience. The degree of difference will depend on the composition of current mixes. The asphalt binder, the aggregate sizes or blends, and the material sources may need to be changed. Drastically different materials may require different handling procedures from those routinely used with current ingredients.



Binders

Depending on the PG grade of the AC/AR/pen graded binders used until now, the new PG-graded binders could impact the construction process in several ways. If a mix producer is involved with multiple projects, the traffic volumes of the different jobs may require that more than one grade of binder be stored at the plant at a given time. Depending on current availability, this variation in binder may create the need for additional storage tanks to provide sufficient on-site production capacity. Even if enough tanks are available, precautions must be taken.

Any material remaining in a storage tank should be purged before adding different binders. Intermixing different grades of PG binders should be avoided. Since there are numerous ways of producing binders of the same PG grade, different formulations of even the same grade may not be compatible and should not be combined in the same tank without knowing their compatibility. Intermixing two binders of the same nominal grade may result in an asphalt which does not meet the requirement. The asphalt supplier should be contacted when considering the intermixing of binders.

The storage temperature of the asphalt binder may need to be adjusted to facilitate pumping from the storage tank to the mixing chamber. Some PG binders will contain some type of modifier. Generally, less storage time is recommended for modified binders and storage temperatures up to 170°C may be necessary. If the binder is to be stored for more than a few days, some suppliers of modified binders recommend lowering the storage temperature after the first three or four days of storage to prevent thermal degradation of the modifier. Thermal degradation can result in the asphalt binder losing its performance benefits. Some of the high-temperature PG binders, especially the highly modified ones, may be considerably stiffer than conventional, unmodified asphalts. This condition may require changes in the capacity of the pumps. Additionally, the meters may need to be recalibrated for binders of different stiffnesses.

Similarly, some means of circulation or agitation of the asphalt within the storage tank may be needed to keep the binder homogenous. In-place horizontal tanks can be adapted with additional mixers in existing manholes. If additional tanks are considered, vertical tanks generally work more efficiently and have less “stagnant zones” in the circulatory flow pattern.

If allowed by the agency, an in-line blending process may sometimes be used to produce PG binders. In-line blending will typically occur in a “mixing unit” installed in the asphalt supply line. Sampling valves should be located downstream of the mixing unit where blending occurs. For this situation, an understanding of the details regarding blending procedures, reaction time, sampling, testing, and acceptance is needed.

Overheating can be a problem for all asphalt binders; however, for some polymer-modified binders, contact with super-heated surfaces (greater than 200°C) should be avoided to prevent thermal degradation. Therefore, tanks with hot-oil heated coils are strongly recommended over tanks that use direct-fired burners.

Common asphalt cement additives such as silicone or liquid anti-stripping agents may change the performance characteristics of any binder. The incorporation of these additives may change the high-temperature portion of the PG classification of marginally graded binders enough to cause the resulting binder to “go out of grade”. This becomes more of a consideration when the additives are introduced into the binder at the mixing plant. The blended asphalt may be used before it can be tested. It is important that the specifier and the contractor mutually agree on how these kinds of additions will be managed.

In any case, the binder supplier should be contacted for instructions regarding storage temperature and time, required circulation, introduction of additives, and any other product-specific needs. The Asphalt Paving Environmental Council’s *Best Management Practices to Minimize Emissions During HMA Construction* provides guidance on handling and management of HMA materials and operations. This document contains a table listing typical asphalt binder storage and mixing temperatures for PG grades.

In order to reduce delays while PG binders are being tested for approval, many agencies have adopted procedures for binder suppliers to certify their material. AASHTO PP26, *Standard Practice for an Approved Supplier Certification System for Suppliers of Performance-Graded Binders*, contains standardized procedures developed by industry and agency personnel. It is recommended that all parties become familiar with the binder approval requirements.

Aggregates

Different aggregate types, shapes, sources, sizes, or combinations may be necessary to meet Superpave requirements. These materials may have different properties that could change the construction characteristics of the mix.

In order to meet all Superpave mix design requirements, several different types or sizes of aggregates may have to be blended. Depending on current capacity, this may call for having additional stockpiles and more cold-feed bins. The type of crusher used to process the aggregate can affect particle shape, which can ultimately influence the VMA. Cubical-shaped particles are preferred in Superpave mixes. The particle shape may be improved by utilizing a different type of crusher.

The blend chosen as the design aggregate structure may also handle differently through the plant. Minor modifications in drying time, screening rate, hot bin balance, mixing time and temperature, etc., should be recognized. Superpave mixes typically have more coarse aggregate than conventional mixes. These coarser mixes may be more difficult to heat and dry, so aggregate handling practices to minimize moisture retention within the aggregate are important. Stockpiling on sloped surfaces that drain away from the working face of the pile and staying above the wet bottom of the stockpile are good practices. Some adjustments to the operating characteristics of the mixing plant may be needed. The flights within the drum, the slope of the drum, and/or the rotational speed of drum may be changed to improve the heating and drying of the aggregate.

Since the aggregates used in Superpave mixes are required to be “clean”, any differences observed may be a positive improvement. The drying time may be reduced and the screening rate for batch plants may be improved. The hot bin balance will depend on how closely the cold-feed aggregates match the design aggregate structure. If there are sizable discrepancies between the anticipated grading of the individual aggregates and the selected final blend, the hot bins will be unbalanced, and some wasting of unneeded aggregate fractions will be necessary. Also, as aggregates move through the mixing operation, degradation or breakdown occurs. The coarser mixtures are more subject to this occurrence. This may result in changes in the volumetric properties of the project mixture compared to the lab mix design results.

Mixtures

In general, experience has shown that Superpave mixes are produced like commonly used mixes. Differences in how the Superpave mixture handle through the plant will obviously depend on how much changed in the mixture specifications. Changes in production rate and the effect on motors, baghouse, potential for segregation, etc., may need to be considered.

For example, because Superpave mixes typically use substantially greater amounts of coarse aggregate (4.75mm to 19mm), slightly larger screens may be needed on the screen deck to maintain production rates. Higher concentrations of coarse aggregate can cause less veiling of aggregate in the drum, possibly resulting in increased stack temperatures. Mixes having these characteristics can be successfully produced as demonstrated by the routine production of open-graded mixes.

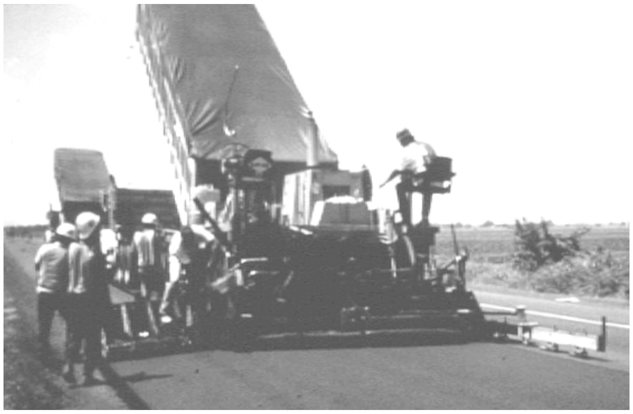
Differences encountered with Superpave mixes can be positive. If clean, low-absorptive aggregate is used, the loads on motors and the dust collection system may actually be reduced and the production rate increased.

Segregation at the Plant

Typically, Superpave mixes will have a higher concentration of coarse aggregate than some conventional mixes. As a result, these mixes may be more prone to segregation than finer-graded mixes. However, segregation may not be as noticeable if the mix is uniformly coarse. Precautionary steps to minimize segregation throughout the plant-related operations should be implemented if they are not part of the current process.

The aggregate stockpiles should be constructed in the proper manner in uniform layers and to a maximum layer depth of four to five feet. The aggregate must be removed from the stockpile and placed (not dropped) into the cold-feed bins in such a way that the material is not segregated. The coated mix should be handled carefully. Conveyors should be aligned so that they do not toss and segregate the particles. If a surge-bin is used, the batcher (or other means of charging the bin) should be timed and operated to drop the material as a single, large mass within the silo.

The loading of the mix into the truck must be done properly. The mix should not be trickled into the truck; it should, again, be dumped in a mass. With surge storage, enough mix should be in the bin or silo to load the truck before starting the loading process. The drops within the truck bed should be positioned to limit the opportunities for larger particles to roll away from the mass. The initial drops should be positioned against the front and back of the truck bed, and then, subsequent drops should be made against the earlier drops.

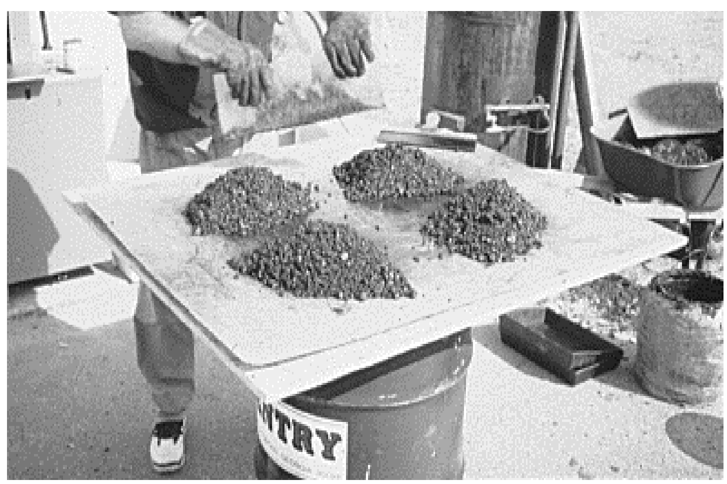


Modified binders will be stiffer than straight run asphalt, so retention of heat to facilitate workability and compaction is important. Covering the truck beds with tarps or insulating the trucks will help minimize the loss of heat.

Quality Control Operations

In selecting the Superpave gyratory compactor as the compaction device for use in the Superpave system, SHRP listed suitability for field quality control (QC) operations as a main concern. By the end of SHRP, many states had implemented, or had considered implementing, verification of the volumetric properties of the asphalt mixture. Therefore, it was necessary that the compaction device for the new mix design and analysis system be useful not only in mix design, but also in field quality control operations. The researchers believed that the Superpave gyratory compactor (SGC) would meet these needs.

Virtually every Superpave test section built since the first projects in 1992 had some form of field quality control testing involving the Superpave gyratory compactor. In 1993, a national research project, NCHRP 9-7, was authorized to study field procedures and equipment to implement the SHRP asphalt research. This research provided recommendations for field quality control testing of Superpave mixtures. In addition, the Federal Highway Administration-sponsored asphalt trailers have provided Superpave field quality control testing assistance.



Although a definitive quality control program has not yet been developed, several key answers to the question of Superpave field quality control testing have been answered. Essentially, Superpave contractor quality control procedures are very similar to current quality control testing programs. Determination of asphalt content and gradation will remain necessary components of a quality control testing program. Superpave has done nothing to dispel or lessen the necessity of these tests.

Determination of asphalt mixture volumetric properties remains a key issue. The main difference in the Superpave QC program and conventional QC programs lies in determination of volumetric properties.

In the Superpave system, a sample consists of a minimum of two specimens compacted using the Superpave gyratory compactor. Current Marshall QC testing plans generally require a minimum of three compacted specimens. The time required for compacting two SGC specimens is approximately the same as the time required for three Marshall specimens. Two SGC specimens are considered sufficient since studies have indicated that the bulk specific gravities of the SGC specimens have a smaller standard deviation than the Marshall specimens. Typically, no additional aging of the asphalt mixture is necessary in the Superpave system.

Once compacted, volumetric analysis is the same for SGC specimens as with Marshall specimens. A noted disadvantage of the SGC is that the specimens are much larger; approximately four times the mass of a Marshall specimen. The larger specimens require longer to cool than the Marshall specimens, thereby slowing the ability to determine the bulk specific gravity of the compacted specimen. This in turn slows QC test results. Consequently, some researchers are attempting to devise a quicker turnaround time on test results.

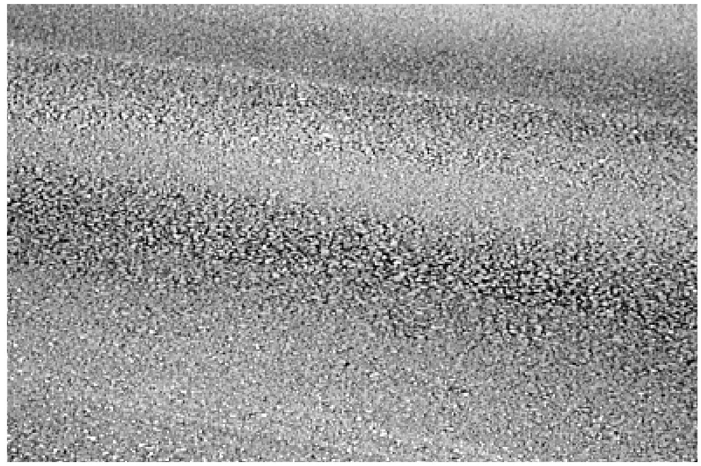
None of the SHRP research or subsequent Superpave implementation research addressed the frequency of sampling. It is assumed that sampling and testing frequency will remain the same using Superpave as with conventional mixtures.

PAVING AND COMPACTION

Experience to date with Superpave mixes has shown that they can be successfully constructed with proper construction practices and reasonable effort. Some Superpave mixes may handle differently than current mixes during the paving and compaction operations. Some of the potential concerns with Superpave mixes, if coarser than the norm, include: minimizing segregation, lessening tender mix problems, limiting hand-working or raking, and achieving density.

Segregation at the Paver

Superpave mixes are not inherently prone to segregation, but some of the design requirements lead to aggregate choices that can be susceptible to segregation. Typically, for projects with heavy traffic, the design aggregate structure of a Superpave mix will contain a relatively high concentration of coarse aggregate. Or, some specifiers may elect to use a mix having a larger maximum size aggregate than the mix that is routinely used. These situations can contribute to the potential for segregation to occur if proper construction practices are not followed.



In addition to the guidelines described previously for materials handling at the plant, standard precautions for handling the mix at the paving site apply. Minimizing segregation on-site begins with correctly unloading the trucks. The mix must be removed from the truck in mass rather than allowing the mix to trickle into the paver hopper from the truck. Truck beds should be lifted slowly to allow the mix to slide back against the tailgate before opening the gate to allow mix to drop into the paver hopper.

The commonly heard warning, “do not dump the hopper wings”, is also appropriate for Superpave mixes. Similarly, the normal recommended practices of keeping an adequate depth of mix in the hopper, feeding sufficient material to the auger, etc., are also applicable. A materials transfer vehicle helps to minimize segregation by “reblending” multiple truckloads of mix as well as maintaining a constant supply of mix to the paver. The quality of the mat may be improved by including such a device in the paving process.

Paver Operations

Some adjustments to the normal operating settings of the paver may be necessary when constructing a Superpave pavement. In particular, the normal operation of the paver screed may be different with Superpave mixes. The same stiffer mix properties that improve rutting resistance are also likely to cause the Superpave mix to be more resistant to easy placement. Typical adjustments may include changing the vertical angle of the screed plate slightly or increasing the effort of the compacting mechanism (vibratory, tamping-bar, etc.) of the screed. If the Superpave mixtures are coarser than typically used, lift thickness may need increasing to ensure a smoothly constructed mat. It is recommended that Superpave mixes be placed in layer thicknesses at least three times the nominal maximum aggregate size.

Handwork and Joint Construction

The properties of Superpave mixes (stiffer binders, higher concentrations of coarse aggregate, more angular coarse aggregate, less rounded sand, etc.) that contribute to the improved rutting resistance may also cause the mix to be more difficult to lute or otherwise work by hand. It is recommended that any handwork be kept to a minimum. Similarly, the relatively coarse aggregate structure selected for some Superpave mixtures may make the construction of a dense, low-permeability longitudinal joint more difficult than for finer graded mixes.
It is important that the paver deliver an adequate amount of non-segregated mixture to the joint.

Compaction

Just as it is for conventional mixtures, compaction is critical to the performance of Superpave-designed pavements. Meeting the compaction requirements may be a bit more difficult than for most conventional mixes. The use of more angular and coarser aggregates and stiffer binders may require greater compactive effort. Superpave's coarser mixes may tend to cool more quickly which results in less time to achieve the target densities. This may require the addition of more rollers and require that careful attention be given to the rolling operation. The coarser Superpave mixes may be more permeable than finer mixes so achieving in-place air voids levels of 6 percent or less is important.

A compaction test strip should be constructed at the beginning of placement of each mixture. The optimum type, sizes, and numbers of rollers, and their operating patterns should be determined prior to mainline paving. The test strip, also, provides material for verification of the plant-produced mixture volumetrics. It further allows for cores to be obtained for developing a correlation to the nuclear density gauge reading. It is important that the same mixing temperature and construction procedures be followed in the test strip as will be used in the actual construction effort. Additional test strips should be constructed when project conditions change. Conditions that might require a new test strip include differing underlying material, changes to the mixture, adjustments to the placement thickness, replacing compaction equipment, etc. A test strip is necessary to optimize the compaction process. Different mixtures require different rolling patterns. The rolling pattern that worked on one project may not be the best choice for another situation.

In general, experience has shown that compaction of most Superpave mixes is best achieved by keeping the breakdown roller immediately behind the paver. For particularly stiff mixtures, the use of two rollers in the breakdown position may be beneficial. The amount of time available to compact a Superpave mix before it stiffens and becomes extremely difficult to compact may be less than for commonly used mixes.

Superpave mix design requirements emphasize the use of clean aggregate and proper volumetric properties. Early experience with some Superpave mixes has shown that some users are designing mixes that have a relatively high VMA. In order to meet the air voids requirements, high binder contents are used with these mixes. This results in a mix that is well lubricated and potentially tender despite meeting all Superpave criteria. An extremely over-asphalted mixture could potentially be subject to asphalt draindown like that sometimes experienced with SMA mixtures. The designer should re-evaluate any mix that appears to have an unusually high VMA and determine if the grading can be revised to achieve a mix that is less susceptible to tenderness and potentially less expensive to produce. It is strongly recommended that asphalt content, VMA, and VFA be reviewed in terms of contributing to potential handling and construction concerns as a final step of every mix design.

Some Superpave mixes have exhibited what has been termed the “Tender Zone”. At intermediate temperatures, the mix begins to become unstable, mark, shove, etc. with additional compactive effort. This phenomenon typically occurs in the temperature range of approximately 240 to 200^{o}F (116 to 93^{o}). Experience has shown that the mat can be satisfactorily compacted above and below this range. However, when the mat temperature is within this intermediate range, the mat cannot be compacted adequately by normal procedures. There are two options for compacting potentially tender mats. The preferred compaction method is to obtain the bulk of the required density before the mat cools to the tender zone temperatures. This can, generally, be accomplished by adding an additional breakdown roller. Then, when the tender behavior begins, stopping rolling until the mat stabilizes. Final rolling is then completed. Another option is to utilize a rubber-tire roller on the tender mat. If pick-up of material is not a problem, rubber-tire rollers normally can be used to compact tender mixes. When tender mixes are encountered, it is still critical to achieve proper densities. If the mixture cannot be compacted, adjustments are necessary.

The exact cause of this Superpave tender mix behavior has not yet been established. It has been theorized that the condition results from the sensitivity of coarse mixes to small changes in the total fluids content of the mixture. The larger particle size, and higher concentration of coarse particles, may retain moisture that helps to lubricate the mass until the binder stiffens and the material stabilizes.

It is possible that a Superpave mix will compact more readily than some conventional mixes. If the local mix generally contained excessive amounts of medium to fine-sized sands (such that the gradation plotted through or above the restricted zone), it may have been easier to place or even tender during rolling. These mixtures may have been compacted by allowing the mat to cool before the application of the rollers. Eliminating the excess sand to meet Superpave requirements may improve the compactability and resolve the tenderness issue.

If the PG binder contains a modifier, exercise care with the use of pneumatic rollers. These binders are usually very sticky and tend to adhere to the rubber tires of the roller even when properly heated. This tackiness can cause pickup of particles from the freshly placed mat. For base courses, this problem may be tolerable, but pneumatic rollers are best avoided when compacting surface mixes containing polymer modifiers.

Conclusion

Some Superpave mixes may handle and respond somewhat differently from the present experience with some current mixes; however, with communication, planning, and attention to good construction practices, these mixes can deliver the superior performance they were designed to provide.